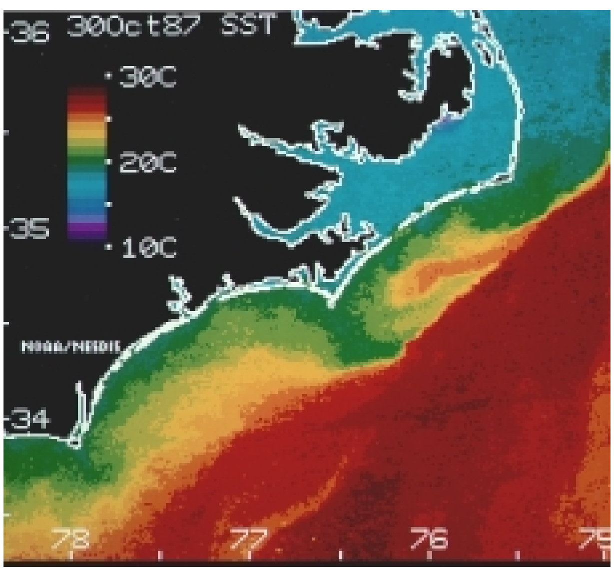
Plankton Ecology and Physiology Team
NOAA Beaufort Laboratory

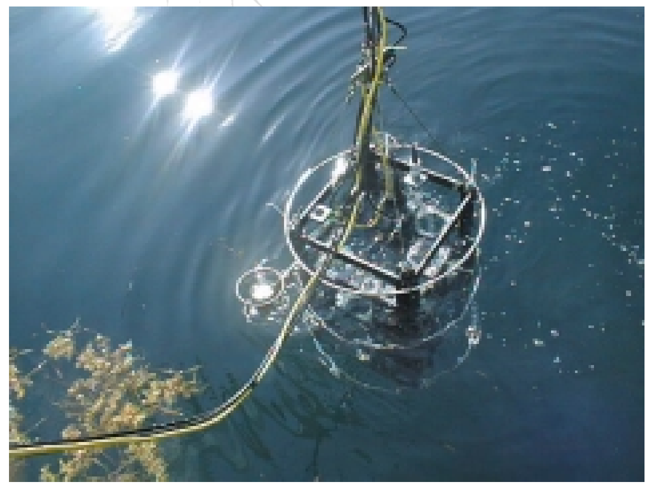
NOAA Beaufort Laboratory has been actively involved in the ecology and oceanography of harmful algal blooms HABs for more than a decade. Here the expertise and strong emphasis has been on the physical aspects of bloom dynamics and transport coupled with the development of remote sensing methods for detection of HABs and the conditions that are conducive to HAB development.



Satellite image of sea surface temperature showing shoreward intrusion of Gulf Stream water. The Gulf Stream served as the transport mechanism for toxic phytoplankton from the Gulf of Mexico in 1987 and a red tide resulted. NOAA-9 AVHRR

What color is the ocean?"

Some of our other activities directly support the calibration of the new SEAWIFS ocean color satellite that provides information on areas of high phytoplankton biomass.



A spectral radiometer measures the color of the ocean at seven wavelengths and is calibrated to the ocean color sensor on the SeaStar satellite.

Also research on trophic transfer of toxins (brevetoxins, domoic acid, cyanotoxins) in critical fisheries habitats and protected species is facilitated by the Laboratory's widely recognized abilities to culture zooplankton and larval fish. Since 1992 research and technique development on the isolation, culture and nutritional ecology of mid-Atlantic and Florida assemblages of *Pfiesteria*-like heterotrophs has helped provide insights to these species and material to both academic and government laboratories. A recent staff addition augments the Laboratory's ability to examine the phylogenetic relationships and molecular ecology of HAB species, including the development of probes for detection and quantification.

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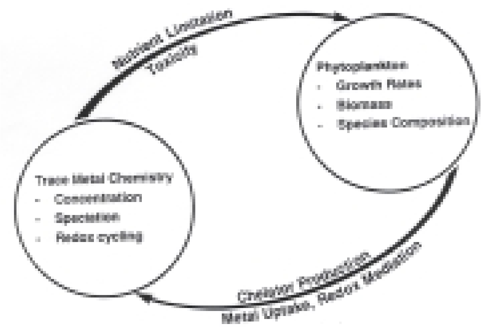
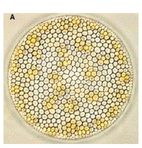
Phytoplankton Physiology and Ecology of Metals

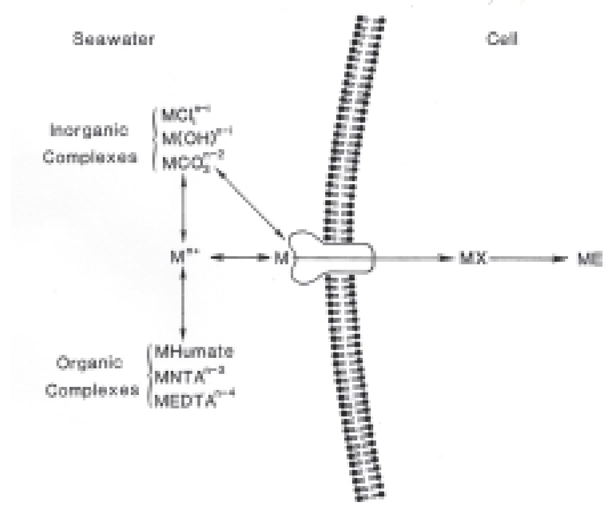
An active program has been in place at the Beaufort Laboratory over the past 20 years to study the factors and processes influencing the interaction of trace metals with marine phytoplankton. Trace metals are of interest because of their roles as both limiting nutrients at and as toxicants at elevated concentrations. The nutrient metals studied here at Beaufort include iron, manganese, zinc and cobalt, while toxic metals examined are cadmium, copper, and zinc.



Much of our work has centered on identifying the factors and mechanisms controlling the accumulation of nutrient and toxic metals by different phytoplankton species and in determining relationships between accumulated metal concentrations and algal growth rate. These studies have indicated that metal accumulation by algal cells is often related to a complex set of factors including: (1) the free ion concentration of the metal, (2) the free ion concentration of competing or interactive metals, (3) cellular growth rate, (4) cell size, and (5) biochemical demand, as determined by the functional need for key metalloenzymes. For example, results of culture experiments we published in a recent paper in Nature Magazine indicate that cellular iron uptake rates per unit of biomass are directly related to the cellular surface to volume ratio, and thus, are inversely related to cell diameter. Therefore, under iron limiting conditions, the growth small cells is favored, influencing algal community composition and food web structure. Likewise, we found that cells needed additional cellular iron to acclimate to low light conditions due to the presence of numerous iron proteins in the photosynthetic apparatus. As a consequence, iron-limited phytoplankton are more likely to be light-limited and vise versa. Thus, marine algae may often be co-limited by iron and light. Since iron limitation favors the growth of small cells, iron availability, light availability, and cells size should be integrally linked in aquatic environments.



In conjunction with our studies of in well-defined laboratory culture systems, we recently have initiated a field study to examine the role of phytoplankton in the fate and effects of toxic metals (copper, cadmium, and zinc) in the Elizabeth River, a highly polluted subestuary of the Southern Chesapeake Bay. This project is funded by the US Navy, and is being conducted in collaboration with a marine chemist (John Donat) and a sedimentary geochemist (Dave Burdige) from Old Dominion University, Norfolk, VA. In this study we are examining the effect of trace metal complexation in controlling metal uptake by phytoplankton and the role of phytoplankton in removing toxic metals from solution and in transporting these metals to the sediments.



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